



UNIVERSITI PUTRA MALAYSIA

**FOREST COVER CHANGE DETECTION AND WATER YIELD
RELATIONSHIP IN SEMENYIH AND LANGAT WATERSHED USING
REMOTE SENSING TECHNIQUE**

MOHD. HASMADI ISMAIL

FH 2000 11

**FOREST COVER CHANGE DETECTION AND WATER YIELD
RELATIONSHIP IN SEMENYIH AND LANGAT WATERSHED USING
REMOTE SENSING TECHNIQUE**

By

MOHD. HASMADI ISMAIL

**Thesis Submitted in Fulfilment of the Requirements for the Degree of
Master of Science in the Faculty of Forestry
Universiti Putra Malaysia**

September 2000

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

SPECIAL DEDICATION

All praise and glory are expressed to Allah S.W.T for His blessings and strengthen me to complete this thesis

Utmost gratitude to my parents, Ismail Yusuf and Jemilah Yusof for your patience, faithfully and never ending prayed for my success

Beloved sisters and brothers, Suriyati, Mohd. Hanapi, Mohd. Hadzlan, Mohd. Nasir, Suhana, Sunita, Suliza, Mohd. Hasbullah, Sulinda, Suzieani and Mohd. Haniff for inspiring in me all the time

and

To my love one in life and faithfully fiancée ***“Princess Nurkasih”***
(*Nor Safarina Ismail*) who is always on my side, never ending support and patience and understand that this success means her success too...

“Tiadakah kamu mengetahui bahawa kerajaan langit dan bumi adalah kepunyaan Allah? Dan tiada bagimu selain Allah seorang pelindung mahupun seorang penolong”
(*Al-Baqarah : Ayat 107*)

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment
of the requirements for the degree of Master of Science

**FOREST COVER CHANGE DETECTION AND WATER YIELD
RELATIONSHIP IN SEMENYIH AND LANGAT WATERSHED USING
REMOTE SENSING TECHNIQUE**

By

MOHD. HASMADI ISMAIL

September 2000

Chairman : Professor Capt. Kamaruzaman Jusoff, Ph.D

Faculty : Forestry

The water supply and its quality would be a worrying situation in the region where there is rapid urbanization, industrial and agriculture development. Lack of proper planning in land use especially in the forest watersheds may lead to the problem of insufficient water supply to the nation. One of the major water supply areas facing problem of water shortage is the Hulu Langat watershed, where the critical recession of water resources at the end of 1990's has been the main drawback of environmental changes in the area. The general objective of this study was to develop a technique of Landsat TM modeling that provides spatial information on the current land use trend in Hulu Langat catchment and its vicinity using remote sensing technology. The specific objectives were as follows: (1) to identify and quantify forest cover depletion surrounding the two dams using three different years of satellite data (1993, 1996 and 1998); (2) to determine the causes and factors influencing water yield in Semenyih and Langat dam and; (3) to map the water turbidity in Langat and Semenyih dam by remote sensing technique with 30m spatial

resolution. Based on the comparison between two multi - temporal imagery of 1993 and 1998, primary forest cover area decreased from 9,316 to 6,818 ha, agriculture/secondary forest area increased from 1,391 to 1,670 ha, urban/clear land increased from 265 ha to 427 ha, and water bodies decreased from 489 ha to 430 ha. The annual percentage of deforestation in the study area was about 0.054 percent per ha per year and the total deforestation was 2, 497.5 ha from 1993 to 1998.

The application of density slicing and contrast stretching techniques to the water portions is promising and showed discrete turbidity ranges coded by grey level or color. Consequently, using visual interpretation of the image and the analysis of the scattergram analysis, four segmentation of water turbidity class in both dams namely 12-13 DN (>9.1 FTU), 9-11 (7.1-9.0 FTU), 4-8 DN (5.1-7.0) and 1-3 DN (<5.0 FTU) were mapped out. From the land cover classification, it was found that the overall accuracy of the generalized land cover map has been observed for each year (1993, 1996 and 1998) was 88.84 percent, 91.52 percent and 87.69 percent, respectively. From the satellite imageries it can be concluded that most of the forest cover decline is due to agricultural activities, timber harvesting and construction of new road network. This study implies that satellite remote sensing technique can be successfully used as a monitoring tool for assessing forest cover loss in a large area and as predictive tool for managing water resources in watershed especially, in spatial mapping of water turbidity levels in big dams. From regression analysis, water yield in Langat and Semenyih dams is positively correlated with vegetation cover at the significance level of 0.01 and 0.05, respectively. However, the temperature and rainfall are not correlated with water yield in both dams.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**PENGESANAN PERUBAHAN LITUPAN HUTAN DAN HUBUNGAN HASIL
AIR DI KAWASAN TADAHAN SEMENYIH DAN LANGAT
MENGUNAKAN TEKNIK REMOTE SENSING**

Oleh

MOHD. HASMADI ISMAIL

September 2000

Pengerusi : Profesor Kapt. Kamaruzaman Jusoff, Ph.D

Fakulti : Perhutanan

Kualiti air dan bekalan air menjadi suatu kebimbangan di rantau ini kerana desakan daripada pembangunan industri, pertanian dan penempatan. Perancangan dan pengurusan yang kurang bijak terhadap penggunaan tanah di kawasan tadahan air dan menyebabkan krisis kekurangan air dan kualitinya wujud di negara ini. Kawasan tadahan air Hulu Langat dipilih di dalam kajian ini kerana ianya menjadi tumpuan bukan sahaja kerana krisis air yang melanda pada tahun 1990'an tetapi kerana ianya kaya dengan litupan hutan yang penting dalam mengawal alam sekitar. Objektif umum kajian ini adalah untuk membangunkan teknik dan model menggunakan data Landsat TM dalam menyediakan analisis reruang mengenai penggunaan tanah di kawasan tadahan air dan sekitarnya. Manakala objektif khusus adalah seperti berikut (1) untuk mengenal pasti dan mengira kadar pengurangan litupan hutan di sekitar kedua-dua empangan Langat dan Semenyih dari tahun 1993, 1996 dan 1998; (2) untuk mengenal pasti faktor yang mempengaruhi hasil air di empangan Langat dan Semenyih dan; (3) untuk mengeluarkan peta kekeruhan air di

empangan Semenyih dan Langat secara teknik penderiaan jauh dengan resolusi 30 meter. Dari perbandingan dua imej satelit tahun 1993 dan 1998, litupan hutan primer berkurangan dari 9,316 kepada 6,818 ha, hutan sekunder/pertanian bertambah dari 1,391 kepada 1,670 ha, kawasan tepubina/tanah lapang bertambah daripada 265 kepada 427 ha dan badan air berkurangan daripada 489 ha kepada 430 ha. Kadar peratusan pengurangan hutan tahunan di kawasan kajian ialah kira-kira 0.054 peratus per ha. dan jumlah kehilangan tanah berhutan ialah 2, 497.5 ha daripada tahun 1993 sehingga tahun 1998. Tahap kekeruhan air dan taburannya boleh dianggarkan dengan kaedah pemprosesan imej ke atas data Landsat TM.

Penggunaan teknik “density slicing” dan “contrast stretching” memberikan kod julat yang berbeza dari segi warna. Dari interpretasi visual ke atas imej dan analisa “scattergram”, empat segmen kelas kekeruhan air di kedua-dua empangan dapat dikeluarkan iaitu 12-13 DN (>9.1 FTU), 9-11 (7.1-9.0 FTU), 4-8 DN (5.1-7.0) and 1-3 DN (<5.0 FTU). Ketepatan keseluruhan keputusan yang diperolehi dari imej tahun 1993, 1996 dan 1998 adalah 88.84 peratus, 91.52 peratus dan 87.69 peratus. Pengurangan kawasan hutan adalah disebabkan oleh aktiviti pertanian, pembalakan dan pembinaan jalanraya yang baru. Dari kajian ini teknik penderiaan jauh berjaya dan boleh digunakan sebagai alat untuk memantau kadar pengurangan hutan di kawasan yang luas dan sebagai alat untuk meramal pengurusan sumber air di kawasan tadahan, begitu juga untuk mengeluarkan peta tahap kekeruhan air di empangan yang besar. Dari analisa regresi, hasil air di empangan Langat dan Semenyih amat positif dengan litupan hutan pada paras keertian 0.01 dan 0.05. Sementara itu, taburan hujan dan suhu tidak mempengaruhi hasil air di kedua-dua empangan.

ACKNOWLEDGEMENTS

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

In the name of Allah S.W.T, most benevolent, ever merciful
All praise to be to Allah S.W.T.

السلام عليكم ورحمة الله وبركاته

First and foremost, Alhamdulillah all praise to the almighty ALLAH S.W.T for His blessings, endless love and merciful that enable me to succeed complete this thesis.

I would like to extent my heartfelt gratitude to my supervisor, Capt. Prof. Dr. Kamaruzaman Jusoff for having confidence in me, for his critical review and guiding me throughout the toughest time and for inspiring me.

My gratitude is also expressed to Associate Professor Dr. Mohd. Kamil Yusoff who is always ready to advise me, and Dr. Wan Nor Azmin Sulaiman for their useful comments on the writing of this project report.

Special appreciation goes to the Malaysian Center for Remote Sensing (MACRES) in providing three data sets of Landsat TM multi temporal data. Sincere appreciation is also express to Puncak Niaga Sdn.Bhd., Selangor Forestry Department, Department of Agriculture Malaysia, Department of Irrigation and Drainage Malaysia and Selangor Water Supply Department for providing useful ancillary data.

Last but not least, special thanks goes to all my colleagues at the Center for Precision Agriculture and Bioresource Remote Sensing, UPM (Zailani, Azian, Sebastian, Dayang, Harzany, etc.) for your support and helping in one or another or in technical work throughout completing this thesis.

I certify that an Examination Committee met on 08 September 2000 to conduct the final examination of Mohd. Hasmadi Ismail on his Master Science thesis entitled "Forest Cover Change Detection and Water Yield Relationship in Semenyih and Langat Watershed using Remote Sensing Technique" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

MOHD. AINUDDIN NURUDDIN, Ph.D.

Head, Department of Forest Management
Faculty of Forestry
Universiti Putra Malaysia
(Chairman)

KAMARUZAMAN JUSOFF, Ph.D.

Professor
Faculty of Forestry
Universiti Putra Malaysia
(Member)

MOHD. KAMIL YUSOFF, Ph.D.

Associate Professor
Faculty of Science and Environmental Studies
Universiti Putra Malaysia
(Member)

WAN NOR AZMIN SULAIMAN, Ph.D.

Lecturer
Faculty of Science and Environmental Studies
Universiti Putra Malaysia
(Member)



MOHD. GHAZALI MOHAYIDIN, Ph.D.
Professor/Deputy Dean of Graduate School
Universiti Putra Malaysia

Date: **14 OCT 2000**

This thesis submitted to the Senate of Universiti Putra Malaysia and was accepted as fulfilment of the requirements for the degree of Master of Science.



KAMIS AWANG, Ph.D.

Associate Professor


Dean of Graduate School,

Universiti Putra Malaysia

Date: **11** JAN 2001

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.


MOHD. HASMADI ISMAIL

Date: **26 SEP 2000**

TABLE OF CONTENTS

	Page
DEDICATION	ii
ABSTRACT	iii
ABSTRAK	v
ACKNOWLEDGEMENTS	vii
APPROVAL SHEETS	vii
DECLARATION FORM	x
LIST OF TABLES	xiv
LIST OF FIGURES	xvi
LIST OF ABBREVIATIONS	xviii
 CHAPTER	
 I INTRODUCTION	 1
General	1
Statement of problem	4
Objectives	8
 II LITERATURE REVIEW	 9
Watershed as an ecosystem	9
Land use planning and watershed management	13
Forest resources and forest conservation in Malaysia	15
Forest for soil and watershed protection	20
Status of water resources in Malaysia	22
Status of water catchment and river basin	23
Water resource in Malaysia: A current issues	24
Water demand and water supply	27
Impacts of forest land use on water yield	28
Impacts of forest land use on water quality and pollution	32
Remote sensing: General fundamental	35
Effect of atmosphere	36
Remote sensing images	37
Electro-optical remote sensing scanner	38
Landsat technology system	40
The capability of Landsat sensor	43
Vegetation change monitoring by remote sensing technology	45
Application of remote sensing in watershed and water management	48
 III MATERIALS AND METHODS	 53
Description of study area	53
Climate	56
Vegetation cover	57
Topography and hydrology	57
Geology and soil	58

Materials	59
Data acquisition	59
Ancillary data	59
Image processing system	60
Global positioning system (GPS)-Trimble GeoExplorer II	60
Methods	61
Digital image processing	61
Pre-processing	63
Image enhancement technique	65
Contrast enhancement	66
Spatial filtering	68
Band Combination	70
Digital image classification	71
Supervised classification	73
Maximum likelihood classifier	75
Change detection approaches	78
Ground truth	80
Accuracy assessment	81
Water turbidity classification and mapping using image processing	83
Sampling method/ground sampling	84
Relevant parameter of water quality measurements	87
Method of analysis	87
In-situ parameter	87
Laboratory analysis parameter	89
Sample preservation and summaries adopted procedure for each selected water quality parameter	90
Forest land cover and water yield modeling	
Regression analysis	91
IV RESULTS AND DISCUSSION	95
Image enhancement, spatial filtering and band combination	95
Image classification	102
Supervised classification	102
Signature analysis	105
Analysis of forest changes	110
Vegetation index (VI) analysis	114
Analysis and interpretation of individual water quality parameter	120
Mapping spatial water turbidity distribution with remote sensing	124
Accuracy assessment	128
The correlation of forest land cover and water yield	133
Causes of deforestation in watershed	137
Field assessment	137

V	CONCLUSIONS AND RECOMMENDATIONS	139
	Conclusions	139
	Recommendations	142
	REFERENCES	144
	APPENDICES	
A	A sample of ground truth survey form	159
B1-2	Temperature, pH and electro-conductivity reading form	160
C1	Regression statistic of Langat dam	162
C2	Correlation statistic of Langat dam	163
D1	Regression statistic of Semenyih dam	164
D2	Correlation statistic of Semenyih dam	165
E1-2	Semenyih data (1993-1998), rainfall, dam volume and temperature	166
E3-4	Langat Data (1993-1998), rainfall, dam Volume and temperature	168
F-J	Sample photographs taken during ground verification	170
	BIODATA OF AUTHOR	174

LIST OF TABLES

Table	Page
1 Eight distinct characteristics of watershed which affect its functioning	11
2 Distribution and areal extent of natural forest in Malaysia	16
3 Permanent forest estate in Malaysia, 1994 (million ha.)	17
4 Water quality classification for Peninsular Malaysia	20
5 Land Use at the Durian Tunggal Dam Catchment in 1987	31
6 Landsat MSS bands and application	44
7 Bands and application of the Landsat TM	45
8 List of selected water quality parameter analysed in this study	87
9 Sample preservation method and summaries of the adopted procedure for water quality parameter	90
10 Magnitude of land cover changes in Hulu Langat watershed from 1993-1998	110
11 Predicted rate of deforestation based on satellite imageries	111
12 Statistic summary of NDVI, TVI and SVI	120
13 Water quality measurement of Semenyih dam	121
14 Water quality measurement of Langat dam	122
15 The DN's of turbidity class and range	125
16 The error matrix for five classes of land cover in Hulu Langat TM 1993 image	129
17 The error matrix for five classes of land cover in Hulu Langat TM 1996 image	130

18	The error matrix for five classes of land cover in Hulu Langat TM 1998 image	131
19	Pearson correlation matrix of Langat dam	134
20	Pearson correlation matrix of Semenyih dam	134
21	Result of regression analysis of Langat dam	136
22	Result of regression analysis of Semenyih dam	136

LIST OF FIGURES

Figure		Page
1	Watershed ecosystem	12
2	Percentage of EMR penetration into the atmosphere as a function of wavelength	37
3	Landsat 4 and 5 configuration	42
4	A map of Peninsular Malaysia showing the location of study area	54
5	A map showing the river systems and Landsat TM image showing the watershed boundaries of Langat and Semenyih dams	55
6	Rainfall distribution of the study area in 1997 (Station: 3018107 and 3118102)	56
7	The flow diagram of study procedure	62
8	Raw data of Landsat TM image 1993,1996 and 1998 showing the Semenyih(A) and Langat dam (B)	64
9	Image-to-image registration in data pre-processing	65
10a-b	(a) LUT's express the characteristic without stretch and (b) LUT's express characteristic of new brightness value in break point stretch of Landsat TM 1996	67
11	Multi-histogram visualize three image plane of the Landsat TM 1996 image	67
12a-c	(a) Median filter, (b) Edge sharpening filter and (c) Mode filter	70
13a-d	Several band combination or FCC showing the different image contrast (a: Band 4-5-3; b: Band 5-4-3; c: Band 7-4-2 and d: Band 7-4-5)	72
14	The window of training areas over the study srea	74
15	Maximum likelihood defining the equiprobility contour	76
16	Various stages of the turbidity classification process	84
17a	1996 Landsat TM image showing selected sampling sites and GPS readings in Langat dam	85

17b	1996 Landsat TM image showing selected sampling sites and GPS readings in Semenyih dam	86
18	Linear enhancement of 1993, 1996 and 1998 Landsat TM images	96
19	Median filter of 1993, 1996 and 1998 Landsat TM image	98
20	1993, 1996 and 1998 images band 4-5-3 (R-G-B)	100
21	1993, 1996 and 1998 images band 7-4-2 (R-G-B)	101
22	Supervised classification of 1993, 1996 and 1998 generating five major land cover of the study area	103
23a	The 1993 spectral reflectance curves for different cover types in the study area	106
23b	The 1996 spectral reflectance curves for different cover types in the study area	107
23c	The 1998 spectral reflectance curves for different cover types in the study area	108
24	Areal extent of land cover increment and decrement in Sg. Langat basin from 1993-1998	113
25	Projection of forest area and water bodies in Hulu Langat	114
26	TVI index image of 1993, 1996 and 1998 over the study area	116
27	SVI index image of 1993, 1996 and 1998 over the study area	117
28	NDVI index image of 1993, 1996 and 1998 over the study area	118
29	The different pH, temperature, electrical conductivity, turbidity, total suspended solid and total dissolved solid value for each sampling station at Langat dam	123
30	The different pH, temperature, electrical conductivity, turbidity, total suspended solid and total dissolved solid value for each sampling station at Semenyih dam	124
31	Turbidity level and spatial distribution of water turbidity in Semenyih (a) and Langat dam (b) of 1996 Landsat TM imagery	127

LIST OF ABBREVIATIONS

DID	Department of Irrigation and Drainage
DN's	Digital numbers
EC	Electrical conductivity
EMR	Electromagnetic radiation
FCC	False color composite
GCP's	Ground control points
GIS	Geographic information system
GPS	Global positioning system
LUT	Look –up table
MACRES	Malaysian Center for Remote Sensing
MLC	Maximum likelihood classifier
MSS	Multi spectral scanner
NDVI	Normalized difference vegetation index
NIR	Near infrared
PFR	Permanent forest reserve
RBD	Return beam vidicon
RSO	Rectified skew othomorphic
SPOT	Satellite Probatoire d' Observation de la Terre
SPSS	Statistical package for social science studies
TDS	Total dissolved solid
TM	Thematic mapper
TSS	Total suspended solid
VI	Vegetation indices

CHAPTER I

INTRODUCTION

General

The tropical forests are undoubtedly the world's richest ecosystem and one of the most valuable natural resources in the developing countries. In Malaysia, a tropical forest not only contributes to socio-economic growth, but is also very important for protection and preservation of environment for human benefits. Forests have many tangible and intangible benefits, such as mediating climate change, preventing erosion and flooding. Besides for the animal conservation, forest material use for food, raw material, shelter, pharmaceutical, recreation and tourism.

Forest plays a critical role in maintaining ecosystem, environmental health, productivity and services. The quality of water we drink, the air we breathe, and the soil in which we grow our food crops depends on the integrity of natural ecosystem. It has long been recognized that significant role of forest in reducing erosion, preventing flood, maintaining the purity of the water, and tempering climatic fluctuation, and thus are vital to the productivity of our streams, lakes and oceans (Mohamad, 1998)

A great portion of land area in Malaysia is currently covered with forest where watershed areas are located. As reservoir of the country's water supply, approximately 97 percent of the fresh water supply for domestic, agricultural, irrigation, industrial and recreational purposes is derived from forest catchments

situated in undisturbed forest. Most of the naturally forested catchments are located in the hilly regions and mountains. Effective management and conservation of these forest catchments results in a clean and high quality water supply, reduced siltation and pollution of rivers. It is clear that developing land resources will accelerate forest exploitation and destruction, which have an adverse impact on the sensitive environment of watershed areas. To attain the achievement in socio-economic progress, Malaysia, however like many developing countries, is still faced with the pressing needs to develop these abundance of natural resources to further improve the quality of life of an increasing population and to provide the base for a stable and sustaining prosperity.

Malaysia is fully aware of the need for effective forest management and conservation not only to ensure a sustained 'tangible' supply of timber but also to maintain 'intangible' environment stability. The conservation of watershed zone at all level is fundamentally importance in the maintenance of viable land use programme by maintaining the scale in their existing range (optimum). This is generally preferable to other courses of action because it allows for continuity adaptation by process of evolution

Gradually, forest area become smaller caused by forest exploitation and destruction for intensive development purposes like agriculture, human settlement, established of industrial park and expansion of new cities. The small portion of forest remained cannot function well as a protection subsystem in the integral watershed system in new environment. As a result, the land capability to support the growth of vegetation in degraded site is diminished. Besides that, it also pollute the river, dam,

catchment, downstream and irrigation canal of the with salt. This entire situation brought a large effect not only to the communities who live around the watershed area.

For the sound implementation of forestry activities, complete, up-to-date and reliable data and information at various levels regarding the forest condition or status are essential. This timely and up-to-date information with respect to the function and mechanism of such changes are essential as it has important impact on climate and ecological complexity. From an ecological point of view, the forest plays a major role in the hydrological cycle and in recycling atmospheric carbon dioxide. They stabilized soil and prevent excess on climate through energy and water exchanges with the atmosphere are not well understood by researchers.

In recent year, Malaysia has experienced in effects of flash flood and drought. These phenomena partly have been attributed to the degradation of natural environment and water yield, possibility caused by forest clearance in the upland area in this country. These activities and their rate persist unchecked apparently, due to the unavailability of relevant, reliable and timely information on the quantitative and qualitative characteristic of forest environment. It is therefore, imperative that a faster and more efficiency system of data collection, processing, storage, retrieval and updating have to be involved. Remote sensing technology would be highly beneficial in improving the efficiency and effectiveness of thematic mapping; natural resource surveying and monitoring; observation of temporal spatial and other changes in the environment (Razani, 1985; Kamaruzaman and Haszuliana, 1998; Mohd. Hasmadi and Kamaruzaman, 1999).

Statement of Problem

Currently, with the decreasing lowland forest in Malaysia, timber harvesting will inevitably be pushed to the hilly areas, which are watersheds and head stream sites. Kamaruzaman and Nik (1992) stated that mechanical destruction appears particularly in the construction of forest road. Another researcher, Zulkifli (1986) stated that major disturbance has been identified in soil erosion problem and sediment production in the river sources. Clearing of forest cover could disturb the water balance, which will subsequently affect river flow, ground water flow and water quantity and quality.

As water is one of the important resources, the demand for adequate water of an acceptable quality at the right place and time has become a problem in Malaysia. In 1986, the domestic and industrial water consumption is estimated at about 1, 277 million m³ /year (Sieh, 1986) and the overall water demand is growing at about 4 percent annually and projected to be about 20 billion m³ and the irrigation demand to about 13.2 billion m³ in year 2020. The annual water demand in 1990 was 1.4 percent, and by the year 2020 will be about 3 percent of the water resources base (Keizrul and Juhaimi, 1996). This increment causes some problem in rural and urban areas, where the water supply is not readily available. This is due to the variability of rainfall in forest catchment from year to year. In addition, water quality of some rivers has deteriorated due to development activities in the catchment areas that often rendered water unfit to use.

Many researchers agree with these problems (Hamilton, 1985; Don, 1986; Shuttleworth *et al*, 1990). Intensive logging activities using mechanized machine have adverse impact on the soil physical properties such as dry bulk density, total pore space, aeration porosity, available water holding capacity, saturated hydraulic conductivity and resistance to penetration (Kamaruzaman, 1991). According to Fox (1972), soil damage through tractor logging in Sabah was estimated at about 20% of the total area harvested. Meanwhile, Marn and Jokker (1982) observed that the occurrences of bare soil increase from 13 percent to 41 percent as the basal area of trees removed increased 1.2m² /ha to 7.2m² /ha. in logging of tropical high forest.

Deforestation and forest degradation are often caused by a combination of action and influence. FAO (1998) reported that some causes are natural such as fire, disease and weather-induced stress, but more often they result from human activities (e.g. land clearing for agriculture, overgrazing, over-extraction of timber and harmful logging practices). The main cause of deforestation in Malaysia is clearing the forest land for cultivation and agricultural project (Khairi and Abdul Hamid, 1985). This can be accepted if the cleared land is converted to permanent agriculture. However, much of the land being cleared is too steep for cultivation, too closed to the hill headwater and was transformed to settlement park and this eventually to be risky to hydrological cycle. In highly sensitive areas, deforestation and forest degradation can lead to spring drying up and to desertification (FAO, 1998). Moreover, this type of practice has been proven to be very destructive to the water resources.

In recent years, awareness of environmental problem and issue among the people in the country has increased tremendously. The latest information about variables of land cover and the nature of transformation of land cover would be a valuable guide for formulating appropriate policies and effective implementation for natural allocation and a under aspect of its utilization and management.

The loss of natural forest may take many forms but the extinction of watershed system is the most critical and irreversible. There has been significant reduction in percentage of the watershed areas and the most common reason is cutting down of forest and polluted wetlands due to changes in land use.

The water supplies in generally a problem in the region where there is rapid urbanization, industrial and agriculture development. Improper land use planning especially in the forested watershed zone will cause a worse situation to the ecology and hydrology environment. Watershed management planning in intensively managed, as found in the hilly areas in Malaysia, is undoubtedly a very complex task (Paso, 1990).

Although the forest lands always accept the pressure from the developers, watershed management planning should have to take into account a great amount of information. Forest inventory is a conventional method for obtaining the required information and supplying it to the planners and managers for make decision. With increasing and often conflicting demands for resource use, the agency need current, reliable information in order to make sound decision. Like other land management agencies, it needs timely and accurate information about the location, quantity,